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Touch-less Interaction Smartphone On Go!

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1. Abstract

A smartphone touch-less interaction based on mixed hardware and software is proposed in this work. The software application renders circle menu application graphics and status information using smart phone's screen, audio. Augmented reality image rendering technology is employed for a convenient finger-phone interaction. The users interact with the application using finger gesture motion behind the camera, which trigger the interaction event and generate activity sequences for interactive buffers. The combination of Contour based Template Matching (CTM) and Tracking-Learning-Detection (TLD) provides a core support for hand-gesture interaction by accurately detecting and tracking the hand gesture.

2. Introduction

Touch-less interaction extends the operation space for interacting with mobiles and helps mitigate the problems of using mobile phone while user's hands are not available, for instance, their hands are dirty, or they are wearing gloves in winter, or they are driving and holding the steering wheel. In addition, touch-less interactions support more gestures in more natural patterns [1]. We present a touch-less interaction approach for smart phones where user mounts smart phone over wrist and performs 'in air' interaction gestures.

3. Our approach

Our approach uses fixing the smartphone on the forearm by a low-cost flexible hardware and tracking the finger motion (behind the screen) to simulate the touch event by a novel algorithm. Our algorithm uses dynamic programming based CTM algorithm [2] to localize the finger-contour and employs TLD [3] framework to strengthen the tracking process in every frame. TLD algorithm combines elements from tracking, learning and detection in the 2D image space to make it a long-term tracker. The TLD tracker uses a tracking strategy of the overlapping blocks, and tracks every block by Lucas-Kanade optical flow method. CTM approach is an indispensable step for interactive hand (two fingers outstretched) detection in the beginning. CTM gives TLD a region of interest (ROI) for initialization.

Our algorithm execution time is real time and accurate even when the hand gesture is moving fast and in image blur cases. It's worth mentioning that the method can detect all kinds of the hand-gesture used in our application, as long as the correct hand texture is detected in the first frame.

To improve the efficiency of the proposed algorithm, the size of first frame is scaled down to 25% and then CTM is applied. From the second frame the image is scaled to 12.5% and then TLD tracking is employed. The 'hand target test' results indicate both efficiency and success rate of the tracking is close to 100%.

4. Results

To verify the accuracy of our algorithm we have tested it on our dataset; which contained 120 mobile video sequences (more than

Figure 1. [From left to right] *User interaction space shown on smart phone's screen augmented with virtual objects. Complete Application Scenario*

1000 frames each) of single hand-gesture for various sizes. Our dataset contained video-sequences from clustered office as well as outdoor lighting conditions. The proposed algorithm successfully located and tracked the hand-gesture in almost all videos.

The overall gesture recognition rate of 99.76% is noted for private video sequences. To evaluate our system, we have developed a proof of concept app where users are asked to perform touch-less clicks and launch desired social media site (as shown in Figure 1). It demonstrates easy-to-use and accurate hand-free interactions.

5. Conclusions

Proposed approach allows user to perform touch-less interaction when their hand are covered and/or busy. We will conduct comprehensive user studies for checking validity and limitations of proposed interaction on smart phones. We believe that it's entirely possible to perform multi-modal tasks and communications using smart phone's touch-less interaction on go!

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